DRAFT

67940

Shielded Soil from
E-W split in House Rock
163.3 grams

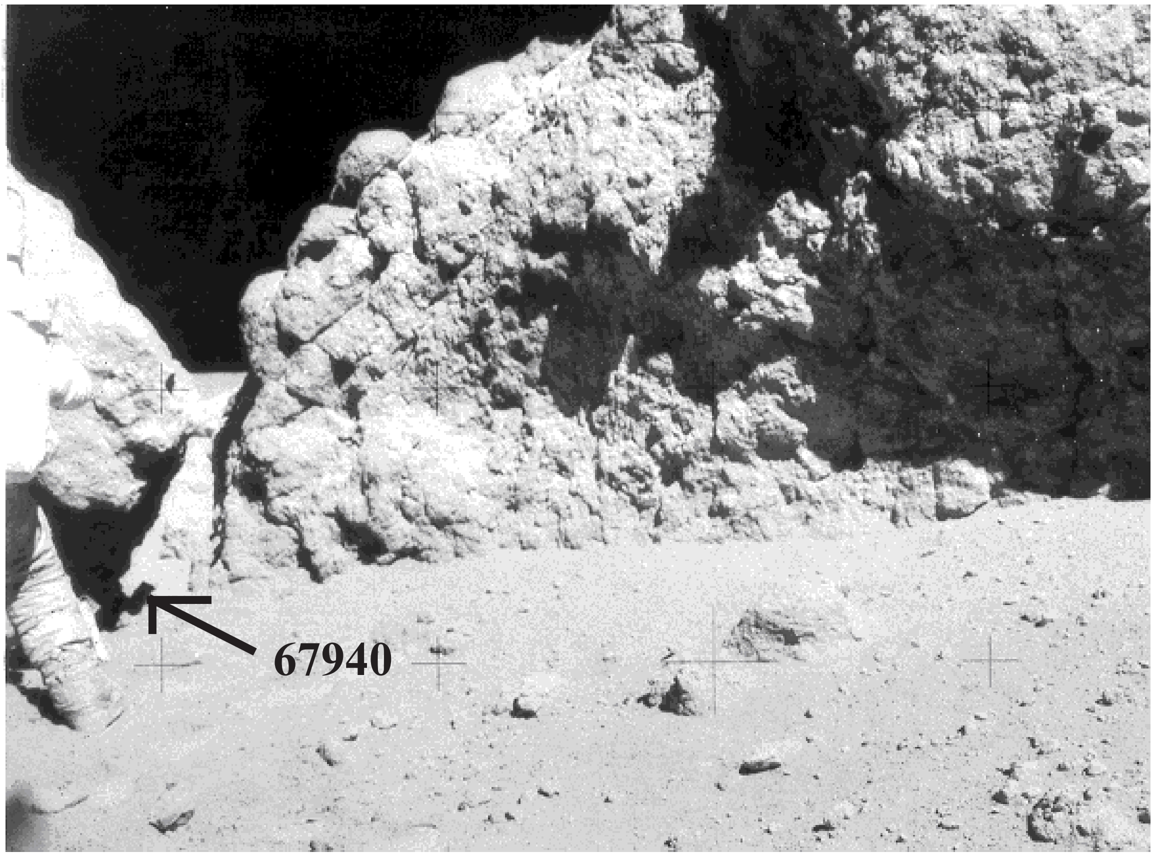

Figure 1: House rock where soil 67940 was collected in a narrow crack between opposing boulders. 67960 was a reference soil from the regolith near the photograpahers location.

Modal content of soils 67941 (90-150 micron).
From Heiken et al. 1973.

Agglutinates	12 %
Basalt	8.3
Breccia	53.2
Anorthosite	2.6
Norite	1.6
Gabbro	0.3
Plagioclase	13.3
Pyroxene	4.6
Olivine	-
Ilmenite	-
Glass other	5.2

Introduction

Soil sample 67940 was collected from the regolith in a narrow E-W split in House Rock, station 11 (Sutton 1981). This sample was specifically collected to check on the idea that ionized rare gases may be accelerated along and redistributed by solar wind electric field along trajectories that are north-south (Horz et al. 1972). 67960 is the reference soil collected about 5 meters to the east of House Rock. House Rock is 3-10 m high and the opposing "Outhouse Rock" 2.5 m high; the crack between them is about 2 m long with the sample location about midway. *This soil is probably not permanently shadowed from the Sun (figure 1).*

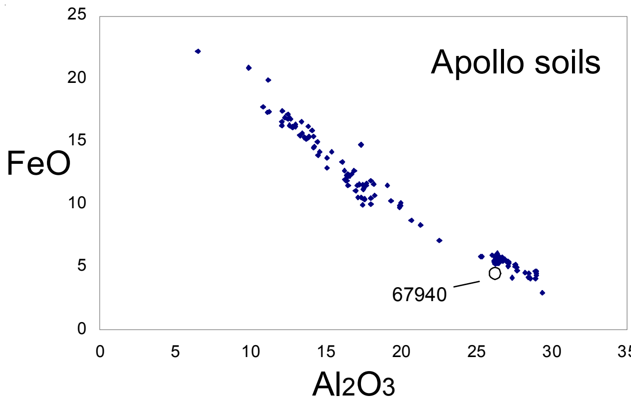

Figure 2: Composition of Apollo soils showing 67940.

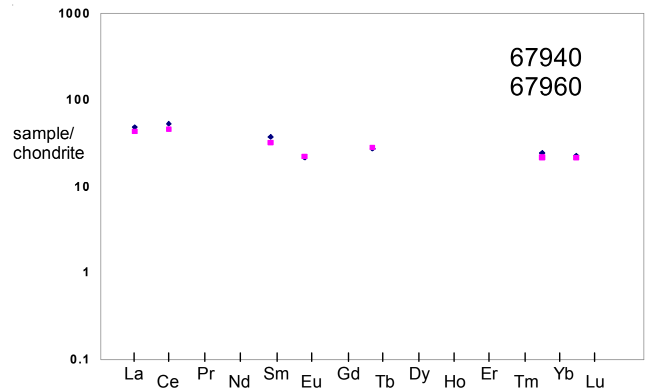

Figure 3: Normalized rare-earth-element diagram for 67940 and 67960 (identical).

Petrography

67940 and 67960 are both immature soils from the near the rim of fresh North Ray Crater. Heiken et al. (1973) reported the mineralogical mode of 67940 – with only 12 % agglutinates. Morris (1978) found 67940 had a low maturity index (Is/FeO = 29). The reference soil (67960) was also immature with Is/FeO = 20.

Powell et al. (1975) studied the mineralogy of the rock fragments in soil 67941. Ryder and Norman (1980) cataloged the fragments (67945-67948) picked from this soil. House Rock and other samples of North Ray Crater are breccias.

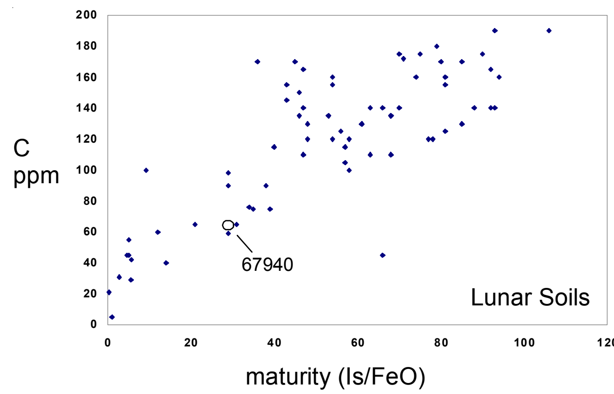

Figure 4: Carbon content and maturity index for 67940.

Chemistry

Rose et al. (1975), Finkelman et al. (1975), Boynton et al. (1975) and Eldridge et al. (1973) determined the composition of 67940 and found it identical to the reference soil 67960 (table 1 and figures 2 and 3). It is typical of the regolith at North Ray Crater. Jovanovic and Reed (1973) studied the halogens in 67941 finding that they were within the range of other Apollo 16 materials. Moore et al. (1975) reported carbon content (figure 4), while Kerridge et al. (1975) reported nitrogen and sulfur contents.

Cosmogenic isotopes and exposure ages

Eberhardt et al. (1976) give the average exposure age of 104 m.y. for 67941 and 95 m.y. for 67960 based on various rare gas isotope determinations. This is to be compared with the 50 m.y. old exposure age of the various boulders thrown out of North Ray Crater (dating the crater). Obviously, these soils contain an ancient regolith component that predates North Ray Crater. Eldridge et al. (1973) found ^{26}Al = 158 dpm/kg and ^{22}Na = 27 dpm/kg for 67941 and Yokoyama et al. (1975) found that 67941 "shows an almost saturated activity in solar cosmic (SCR) produced ^{26}Al, in spite of complete shielding from SCR, which can be interpreted as the result of an intense lateral transport."

Other Studies

Eberhardt et al. (1976) carefully studied 67940 and multiple grain size separates of this sample for all the isotopes of the rare gases (figure 5 and 6). They found high excess ^{4}He and ^{40}Ar which is typical of soils from the rims of relatively recent craters. However, they did not find less excess ^{40}Ar in the shielded soil (67940) than the reference soil (67960), which had been predicted.

Wieler et al. (1980) included 67940 in their careful study of solar flare tracks compared with implanted solar wind rare gases. In general, they find a relatively constant ratio of tracks to implanted ions (ie.^{36}Ar) but 67940 was significantly off the line (figure 7).

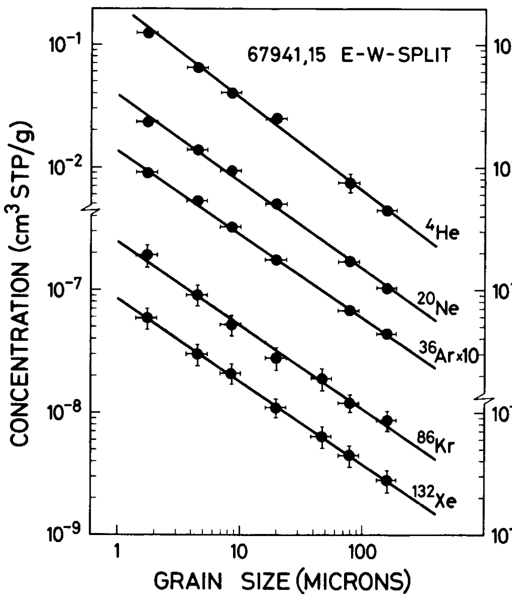

Figure 5: Rare gas as function of grain size for 67941 (Eberhardt et al. 1976).

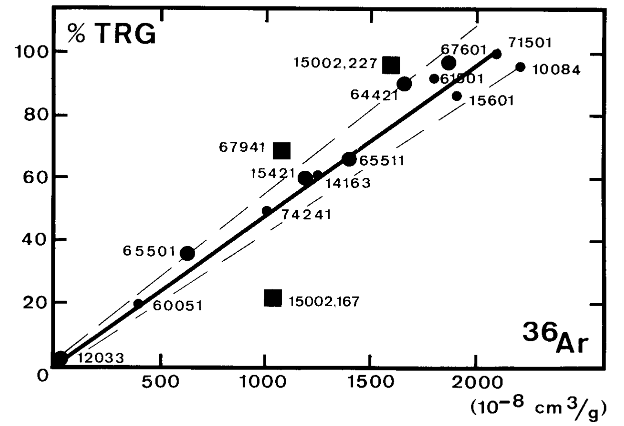

Figure 7: Percentage of track-rich grains plotted versus 36Ar (from Wieler et al. 1980).

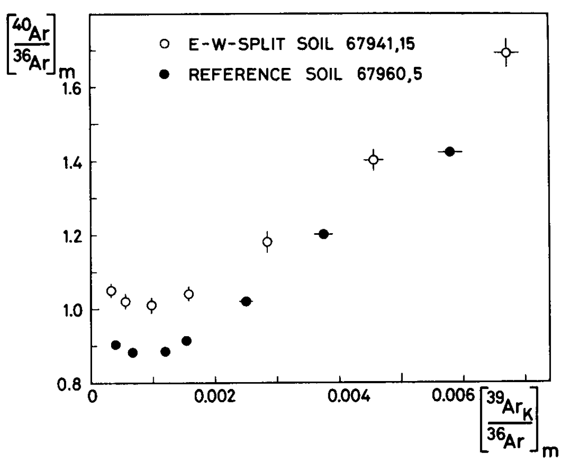

Figure 6: Argon isotopic data for shadowed soil 67941 compared with control 67961 (Eberhardt et al. 1976). This shows that Ar is not a linear mixture of surface and volume correlated Ar.

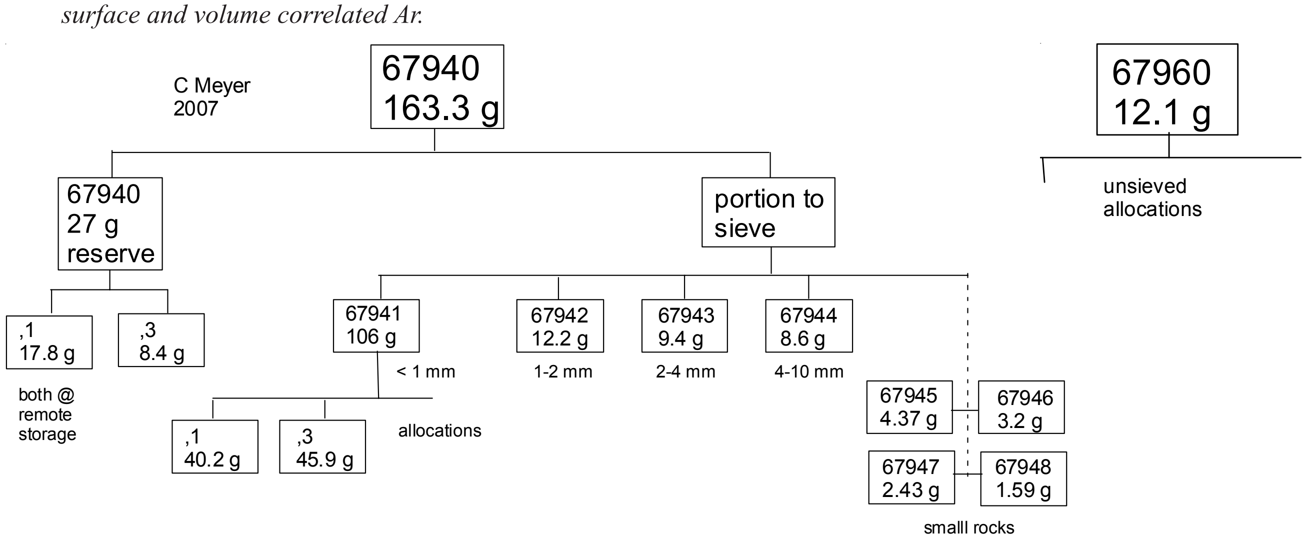

Table 1. Chemical composition of 67941.

									67960		67960			
reference	Rose75		Finkelman75			Boynton75			Korotev82		Philpotts73		Eldridge73	
weight			1000-30	<30microns		400 mg	300 mg							
SiO2 %	45.75	(c)												
TiO2	0.54	(c)												
Al2O3	26.18	(c)				26.26		(a)						
FeO	4.73	(c)				4.5	4.76	(a)	4.56	(a)				
MnO	0.06	(c)				0.08		(a)						
MgO	6.48	(c)				6.48		(a)						
CaO	15.56	(c)				15.25	15.39	(a)	16.1	(a)				
Na2O	0.53	(c)				0.52	0.51	(a)	0.527	(a)				
K2O	0.14	(c)									0.113	(f)	0.13	(b)
P2O5	0.1	(c)												
S %														
sum														
Sc ppm	9	(c)	9	9	(d)	7.8	8.1	(a)	7.76	(a)				
V	15	(c)	17	13	(d)									
Cr	615	(c)				660	700	(a)	624	(a)				
Co	16	(c)	18	9	(d)	22	18	(a)	16.2	(a)				
Ni	319	(c)	460	270	(d)		271	(e)	215	(a)				
Cu	11	(c)	4	8	(d)									
Zn	10	(c)	7	15	(d)		11.6	(e)						
Ga	3.7	(c)	3	3	(d)		4.88	(e)						
Ge ppb							570	(e)						
As														
Se														
Rb	2.2	(c)	11		(d)						2.79	(f)		
Sr	141	(c)	220	200	(d)				175	(a)	178	(f)		
Y	38	(c)	41	36	(d)									
Zr	150	(c)	165	109	(d)				175	(a)				
Nb														
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb							42	(e)						
In ppb							5.8	(e)						
Sn ppb														
Sb ppb														
Te ppb														
Cs ppm									0.13	(a)				
Ba	148	(c)	87	87	(d)		120	(a)	127	(a)				
La						11.3	11.5	(a)	10.14	(a)				
Ce						30	34	(a)	27.6	(a)				
Pr														
Nd														
Sm						5.4	5.5	(a)	4.77	(a)				
Eu						1.12	1.27	(a)	1.248	(a)				
Gd														
Tb						0.9	1	(a)	1.04	(a)				
Dy														
Ho														
Er														
Tm														
Yb	4	(c)	2.3	2.9	(d)	3.5	4	(a)	3.53	(a)				
Lu						0.51	0.58	(a)	0.519	(a)				
Hf						3.4	4.2	(a)	3.77	(a)				
Ta									0.532	(a)				
W ppb														
Re ppb														
Os ppb														
Ir ppb							7.2	(e)	5.3	(a)				
Pt ppb														
Au ppb							7.4	(e)						
Th ppm						2	2.1	(a)	1.88	(a)			1.89	(b)
U ppm									0.51	(a)			0.55	(b)

technique: (a) INAA, (b) radiation counting, (c) microchemical, (d) OES, (e) RNAA, (f) idma

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